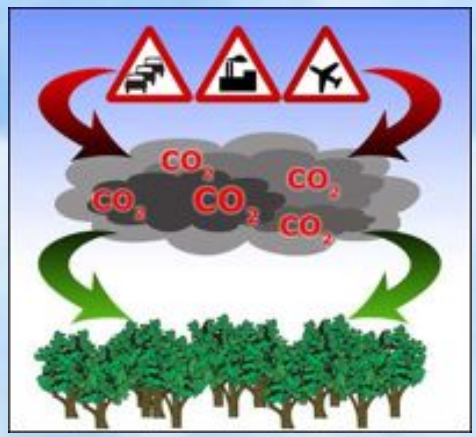


Energy, CO_2, Climate, and YOU!

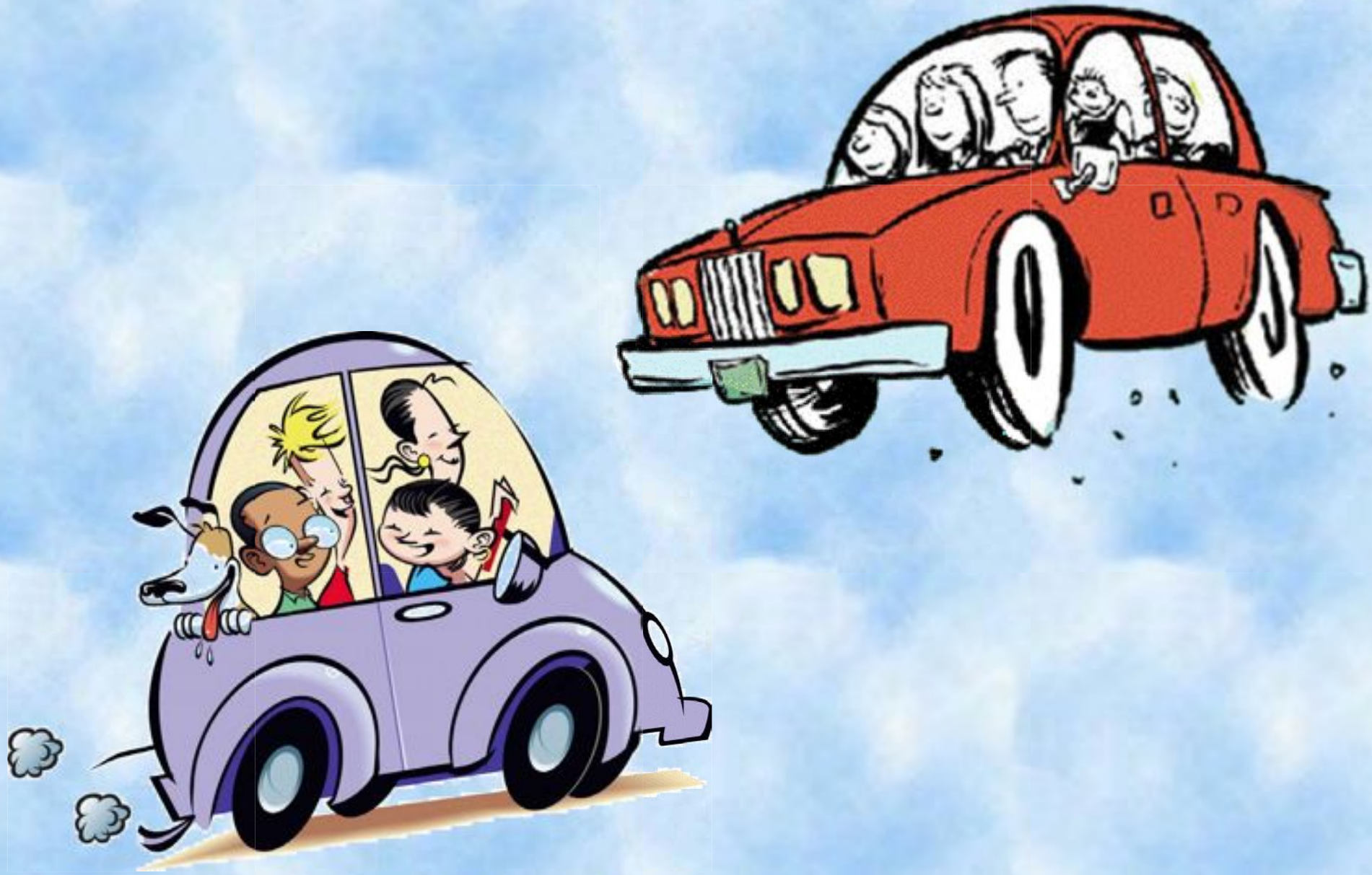
Stephen E. Schwartz

BROOKHAVEN
NATIONAL LABORATORY

summer sundays

www.ecd.bnl.gov/steve

CARPOOLING TO SUMMER SUNDAY AT BNL



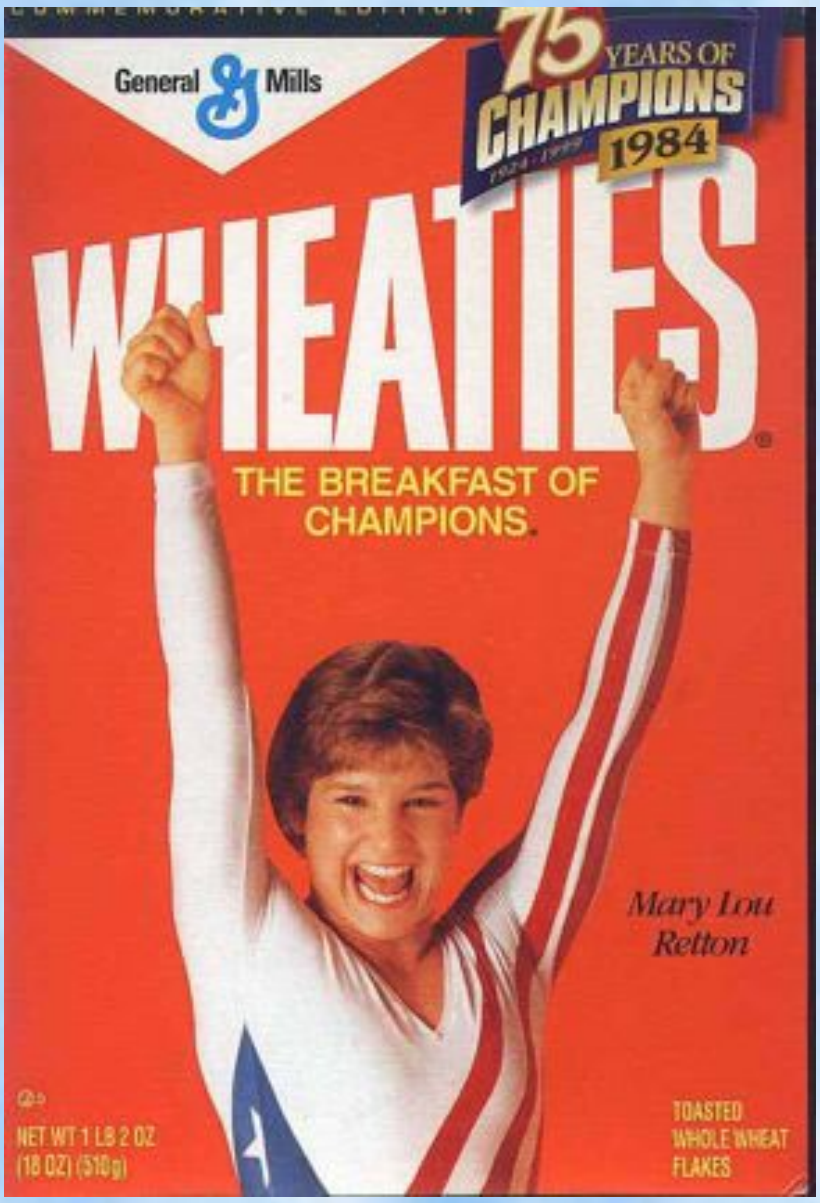
THE MOST EFFECTIVE WAY TO DOUBLE THE FUEL ECONOMY OF A CAR . . .

IS TO PUT TWO PEOPLE IN IT!

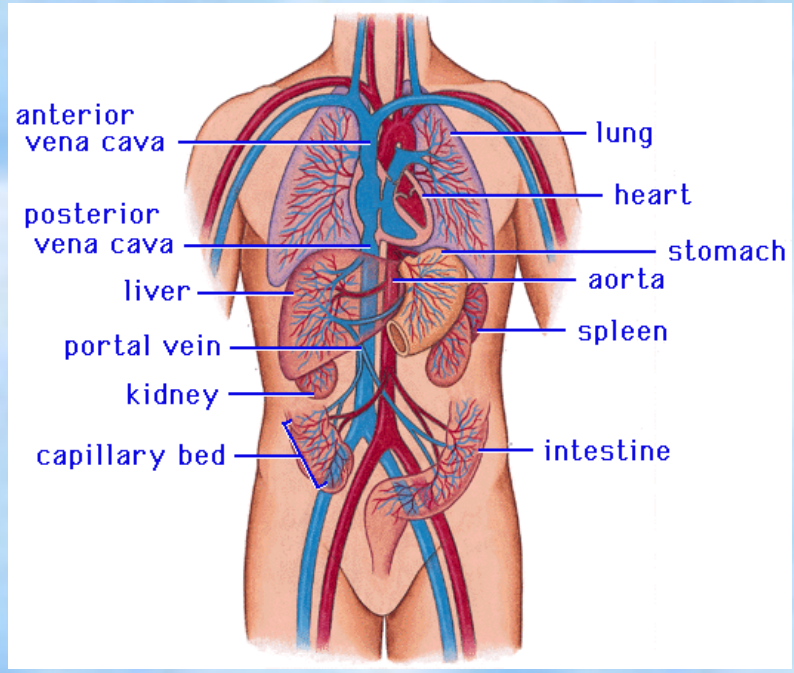
CARPOOLING CAN SAVE MORE THAN GAS

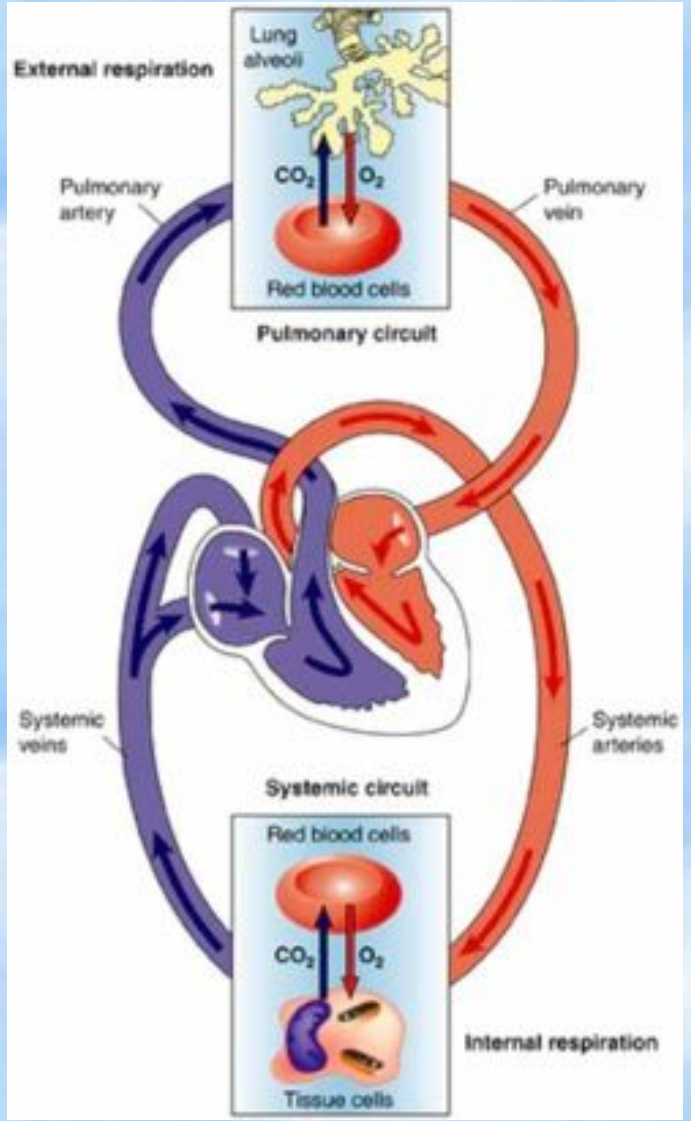
Energy

WHERE DO YOU GET YOUR ENERGY?



HOW DO ENERGY AND OXYGEN GET TO YOUR MUSCLES?

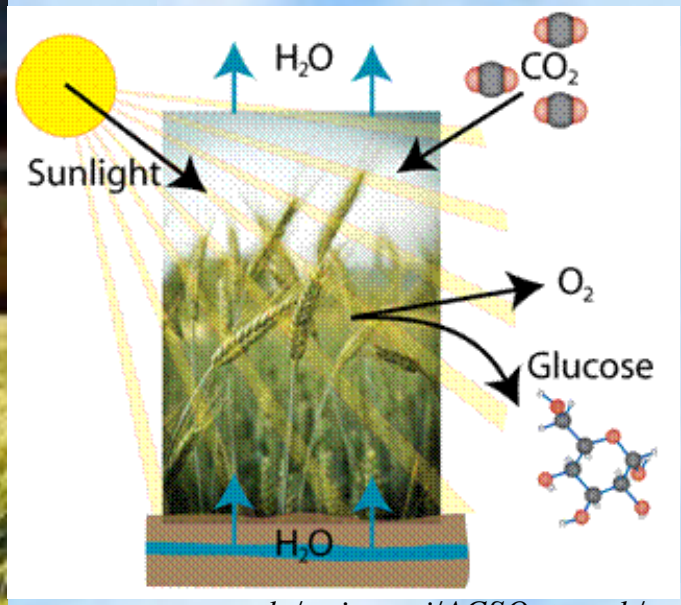




http://www.prevent-stroke-and-heart-attack.com
http://library.thinkquest.org/5777/cir1.htm
http://newstt.com/how-is-circulatory-system-and-the-digestive-system-related/

WHERE DOES YOUR FOOD GET *ITS* ENERGY?

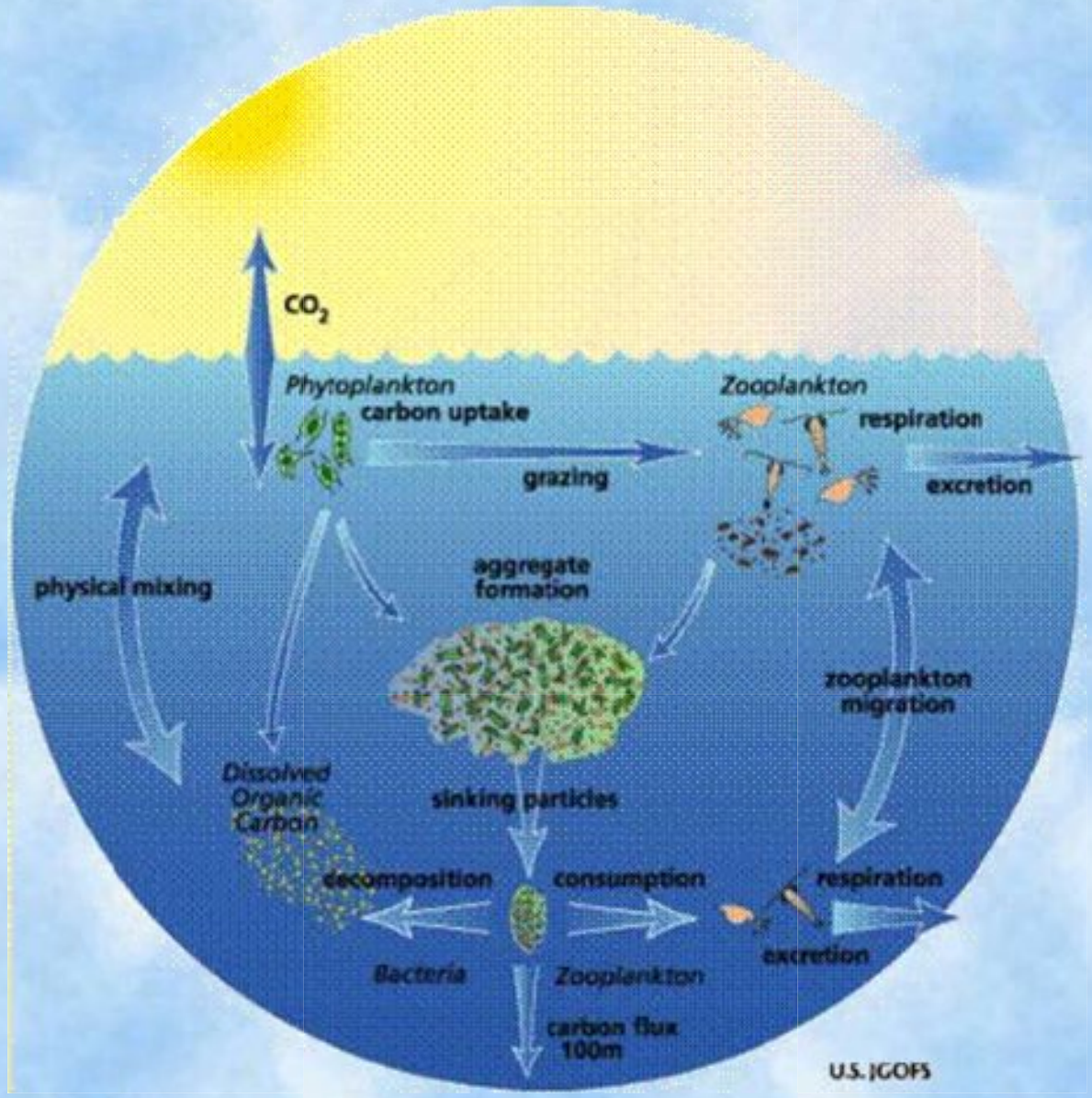
www.desktopwallpaperhd.com

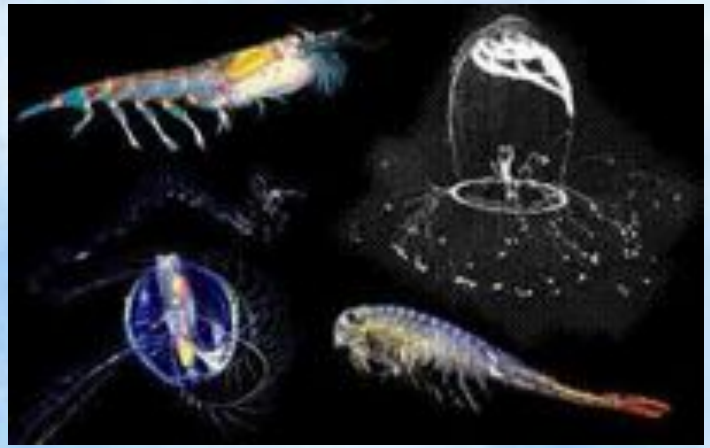


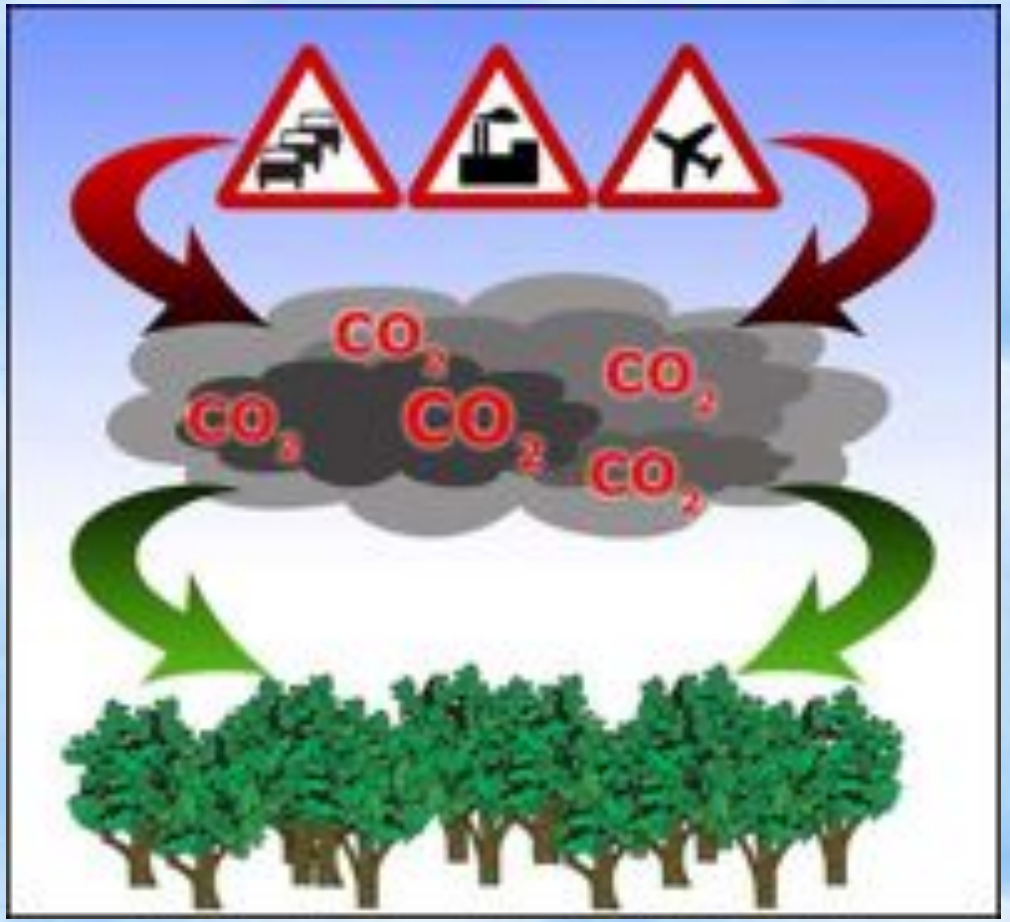
www.ems.psu.edu/~pisupati/ACSOutreach/Petroleum_1.html

WHERE DOES YOUR CAR GET *ITS* ENERGY?

WHERE DOES GASOLINE GET *ITS* ENERGY?



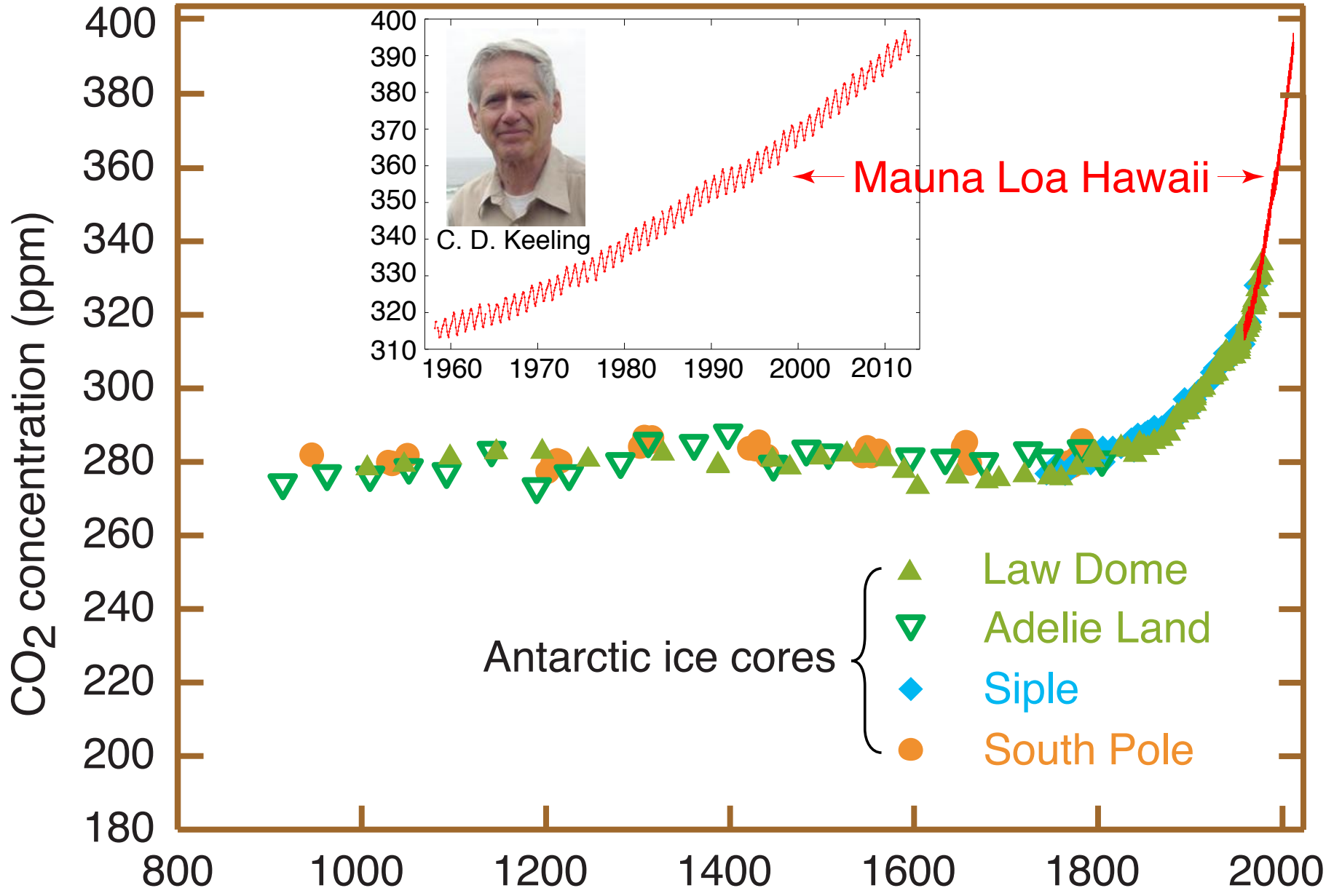




CO_2

Carbon Dioxide

ATMOSPHERIC CARBON DIOXIDE IS INCREASING



Global carbon dioxide concentration over the last thousand years

WHERE IS ALL THIS CO_2 COMING FROM?

WHO IS RESPONSIBLE?

HOW MUCH CARBON IS IN A GALLON OF GASOLINE?

1 lb?

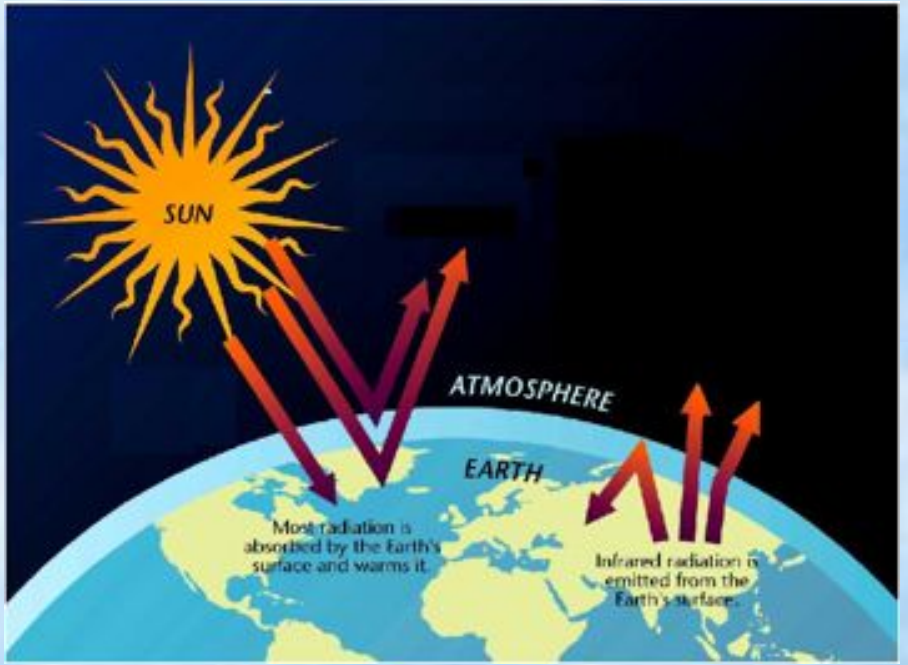
2 lbs?

3 lbs!?

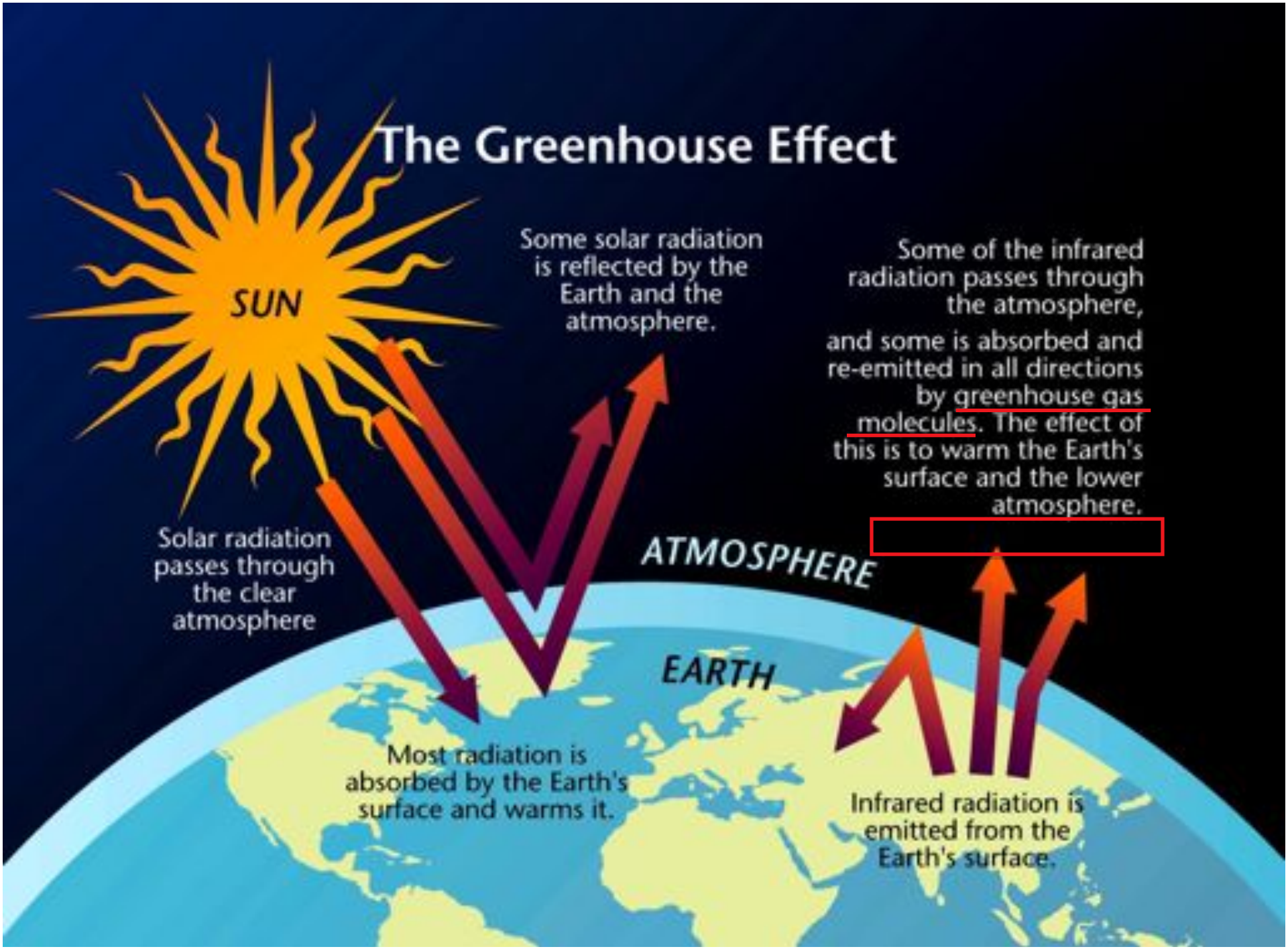
5 lbs!?!

All of this carbon goes into the atmosphere as carbon dioxide when you burn the gasoline in your car.

Climate


SUN
ATMOSPHERE
EARTH
Most radiation is absorbed by the Earth's surface and warms it.
Infrared radiation is emitted from the Earth's surface.


HOT
F
C


The Greenhouse Effect
SUN
Some solar radiation is reflected by the Earth and the atmosphere.
Some of the infrared radiation passes through the atmosphere,
and some is absorbed and re-emitted in all directions by greenhouse gas molecules. The effect of this is to warm the Earth's surface and the lower atmosphere.
Solar radiation passes through the clear atmosphere
ATMOSPHERE
EARTH
Most radiation is absorbed by the Earth's surface and warms it.
Infrared radiation is emitted from the Earth's surface.

THE GREENHOUSE EFFECT

EARTH'S ENERGY BUDGET: A DELICATE BALANCE

- Sunlight heats the Earth.
- The warm Earth radiates energy (in the form of infrared radiation, or heat) back out to space.
- Some of this infrared radiation is trapped in the atmosphere, giving Earth its temperate climate.

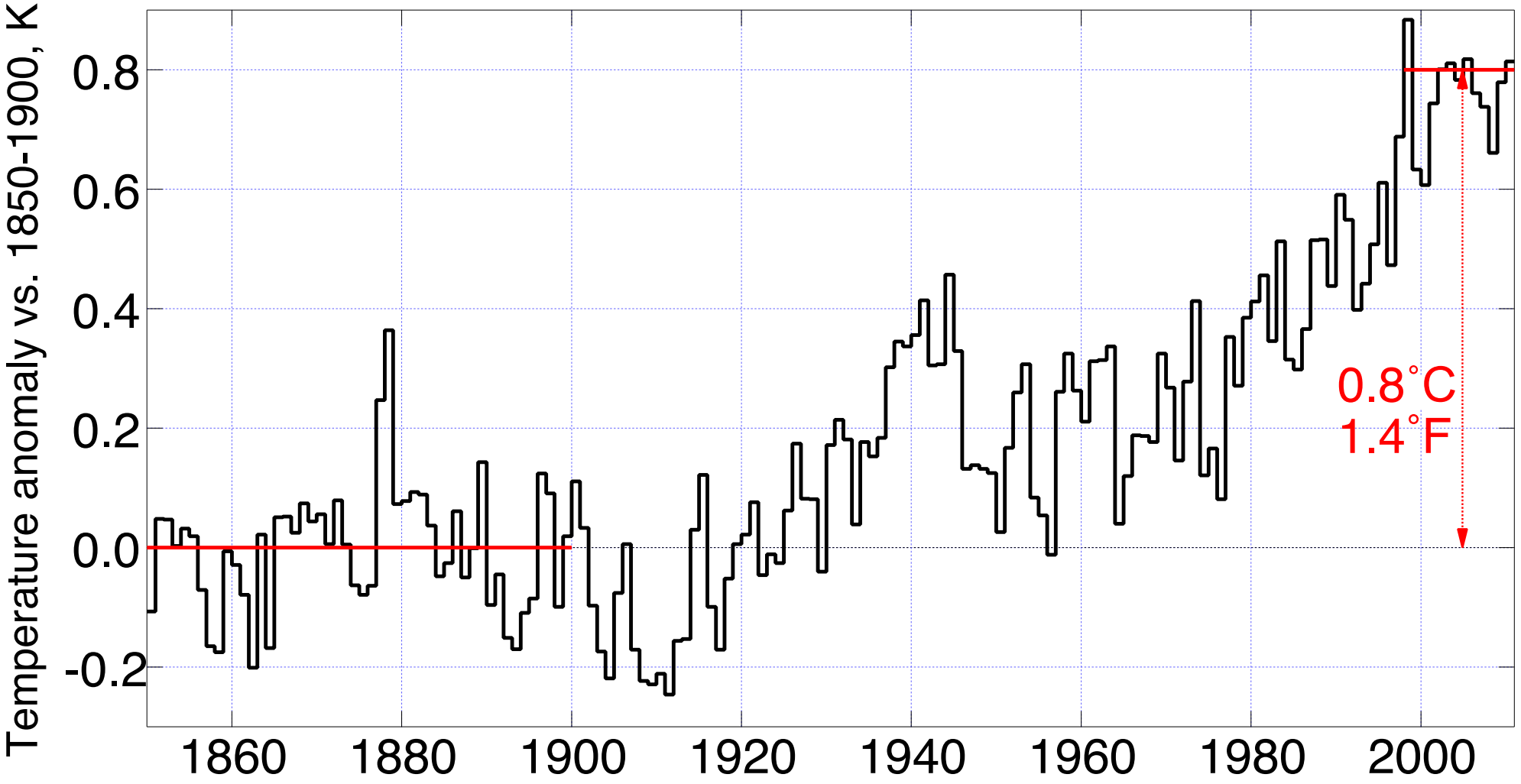
This is the greenhouse effect.

Global average temperature 15°C or 59°F

Without it, the Earth's climate would be like the moon's, harsh and severe.

Global average temperature -19°C or -2 °F

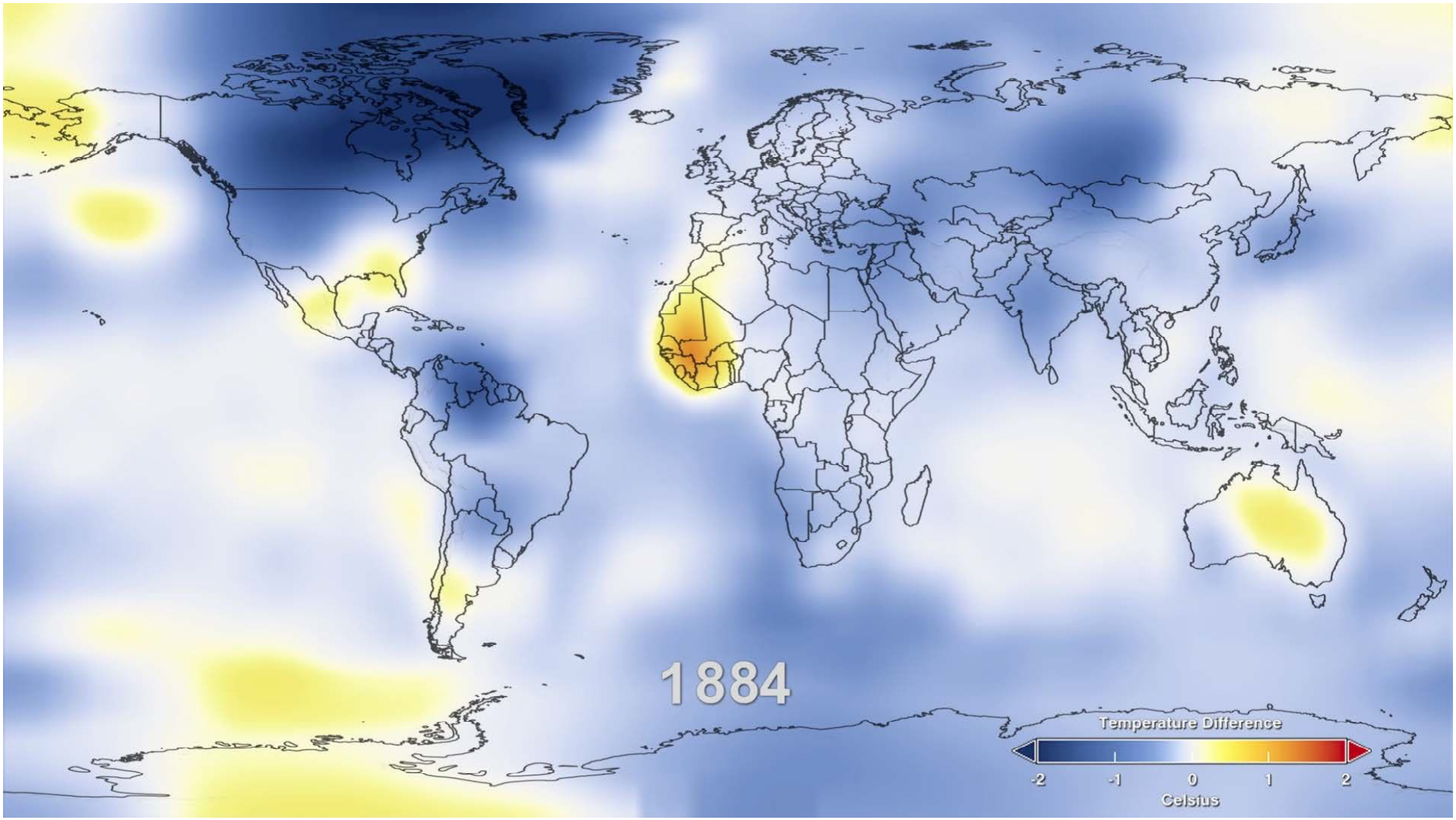
GLOBAL TEMPERATURE CHANGE SINCE 1850



Climatic Research Unit, East Anglia, UK

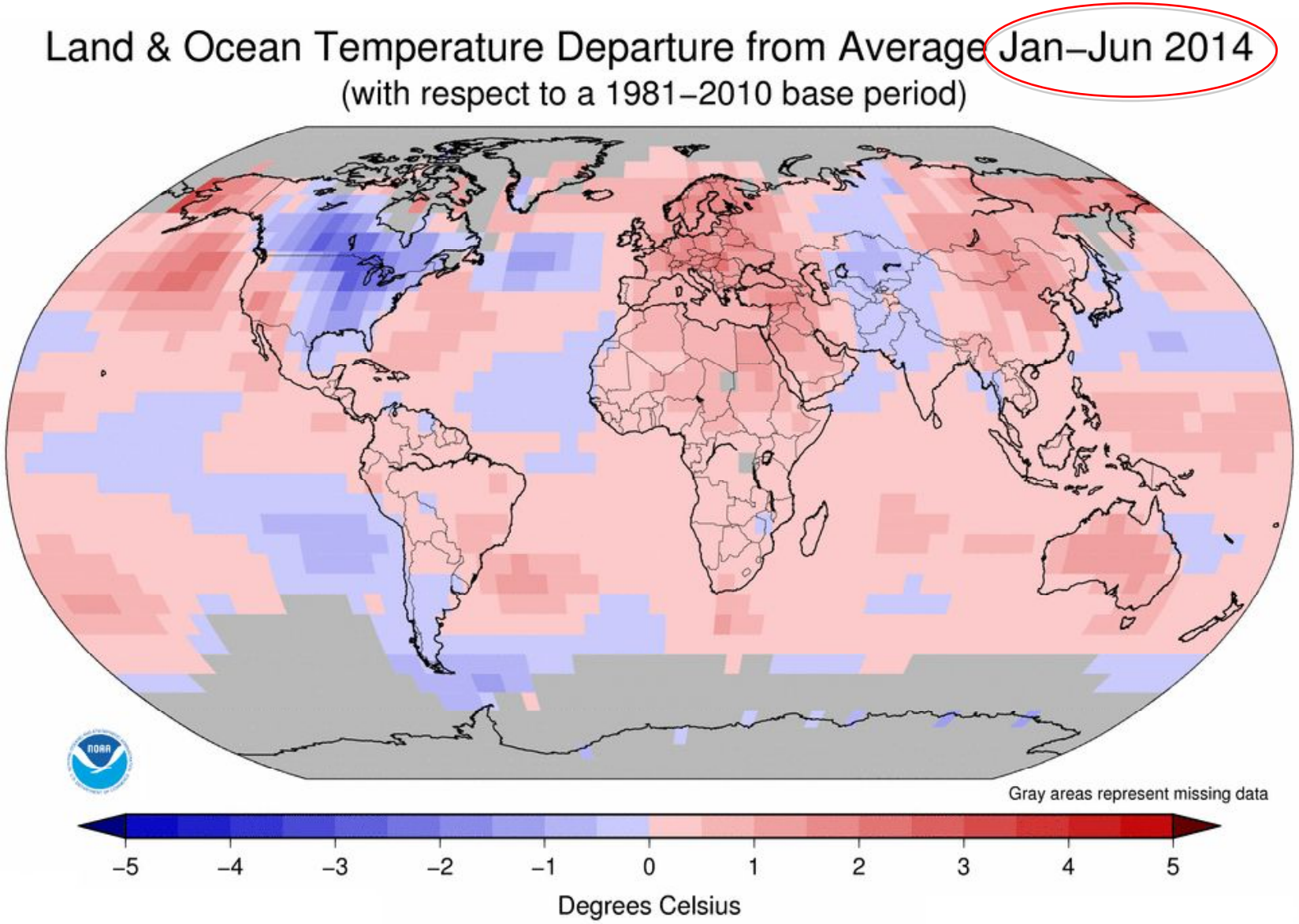
THE WARMING PLANET

Five-Year-Average Temperature Anomalies Relative to Mid 20th Century



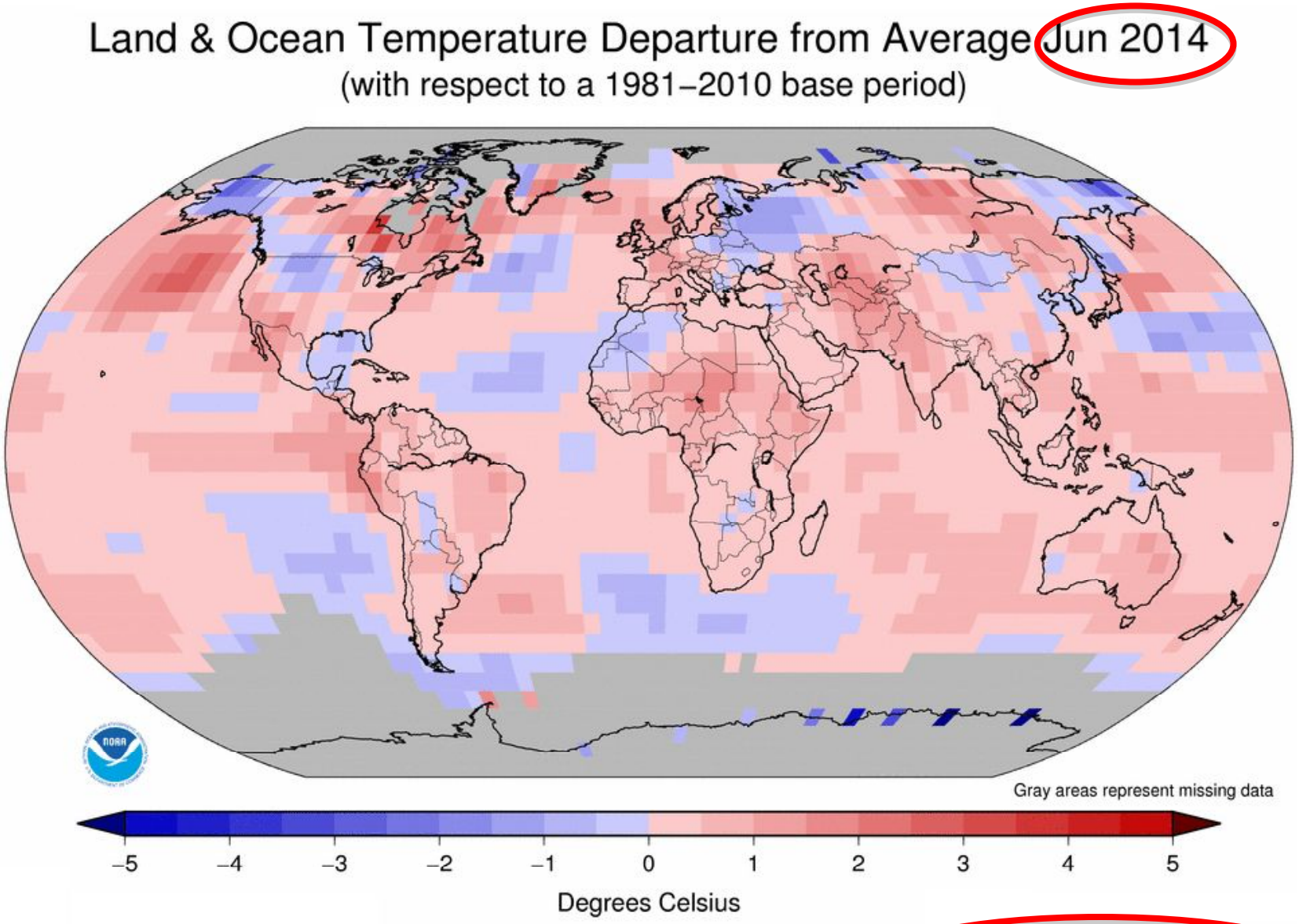
NASA Goddard Institute for Space Studies

ABNORMALLY HIGH TEMPERATURES



- The first half of 2014 tied with 2002 as the third warmest such period on record, at 0.67°C (1.21°F) above the 20th century average.

RECORD HIGH TEMPERATURES



- Global average temperature for June 2014 was record high for June, at 0.72°C (1.30°F) above the 20th century average.

GLACIERS

A RECORD OF CHANGE

PASTERZE GLACIER, AUSTRIA 1875 - 2004

About 2 km shorter.
Terminus replaced by artificial lake.
Decrease in length about 15 meters per year.
In 2003, decrease was 30 m in length and 6.5 m in thickness.

GRINNELL GLACIER
GLACIER NATIONAL PARK 1911 - 2000

MUIR GLACIER - MUIR INLET
GLACIER BAY NATIONAL PARK, ALASKA
1941 vs. 2004

Muir Glacier, William O. Field on 13 August 1941 and by Bruce F. Molnia on 31 August 2004

UPSALA GLACIER, ANDES, ARGENTINA

1928

2004

www.time.com

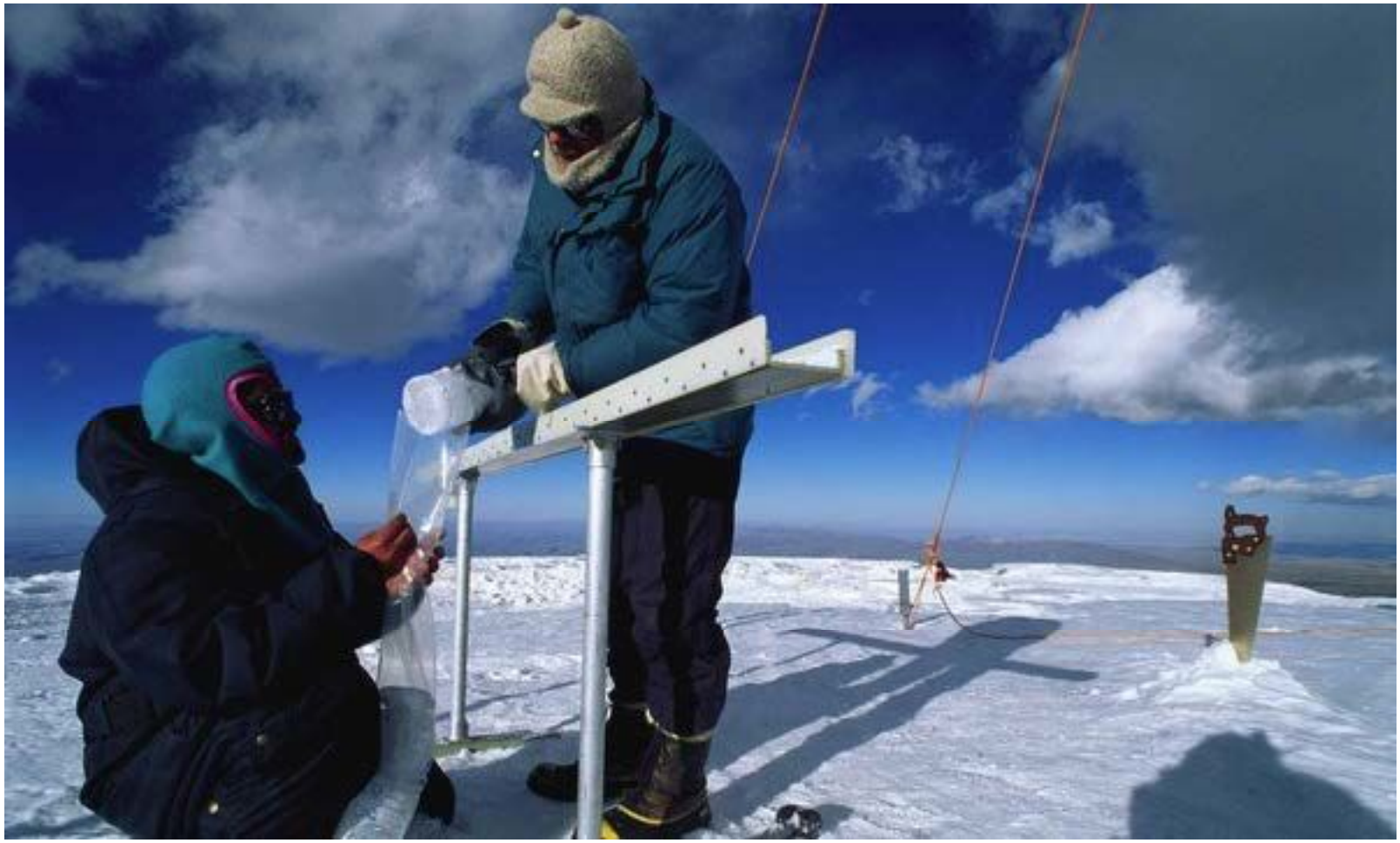
RHONE GLACIER, VALAIS, SWITZERLAND
1859 - 2001

Glacial retreat is 2.5 km.

Base is 450 meters higher.

STUDYING EARTH'S CLIMATE HISTORY

"A Climate Scientist Battles Time and Mortality"



New York Times, July 2, 2012

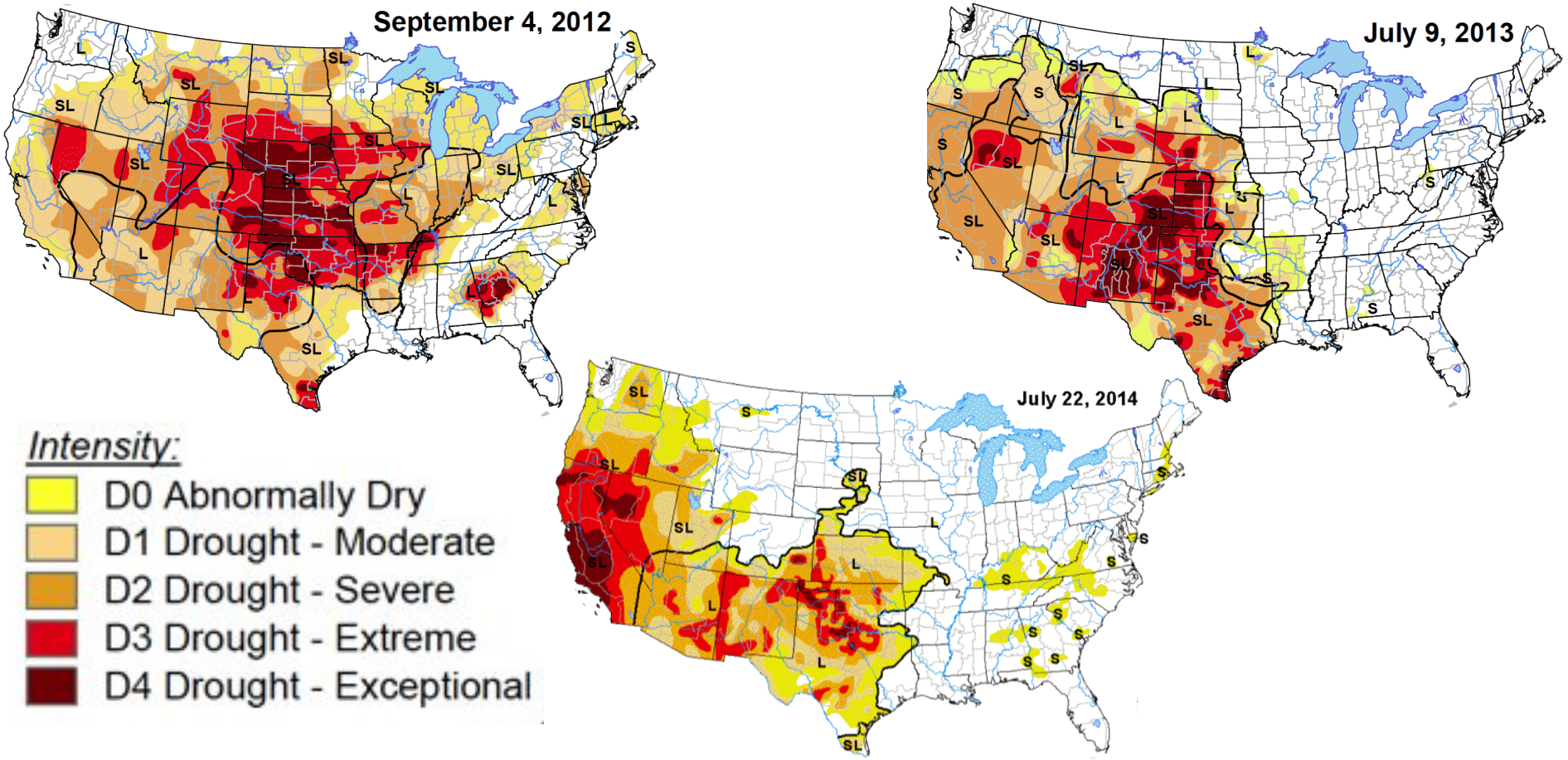
Lonnie Thompson, Ohio State University glaciologist, studies Earth's climate history by the ice archive.

The glaciers are melting, erasing our history.

THE NEW NORMAL?

THE NEW NORMAL?

U.S. Drought Monitor

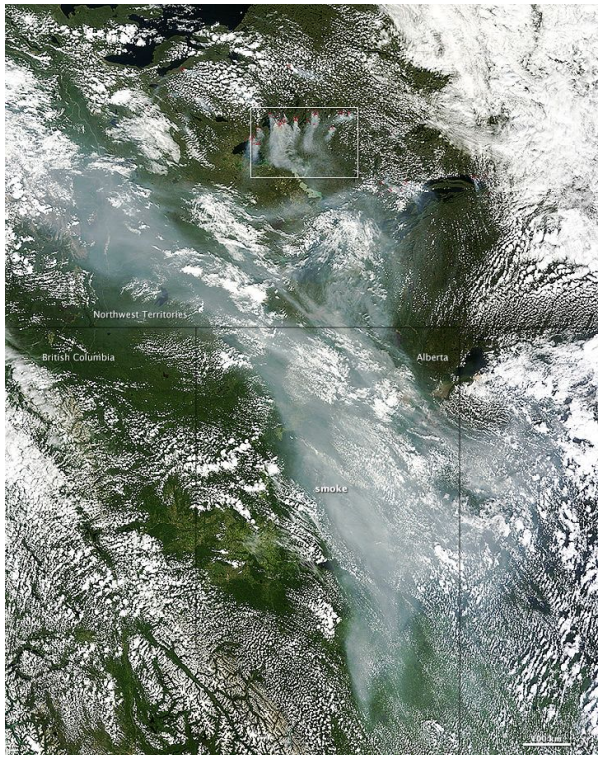


Precipitation deficits for the period May through August 2012 were the ***most severe since official measurements began in 1895***, eclipsing the driest summers of 1934 and 1936 that occurred during the height of the Dust Bowl .

THE NEW NORMAL?

Fires and smoke in northwest Canada, July, 2014

25 km

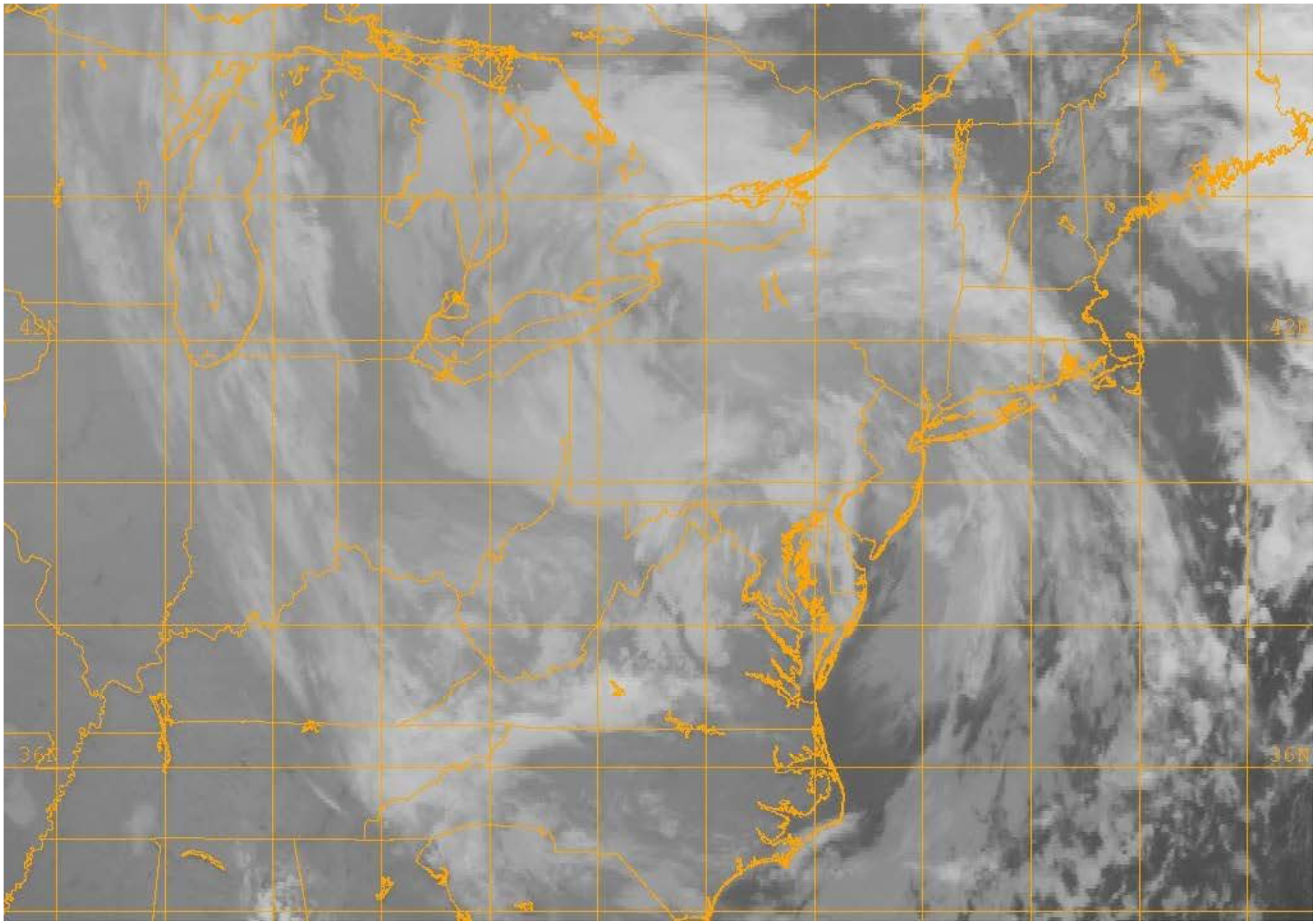


100 km

SUPERSTORM SANDY

THE NEW NORMAL?

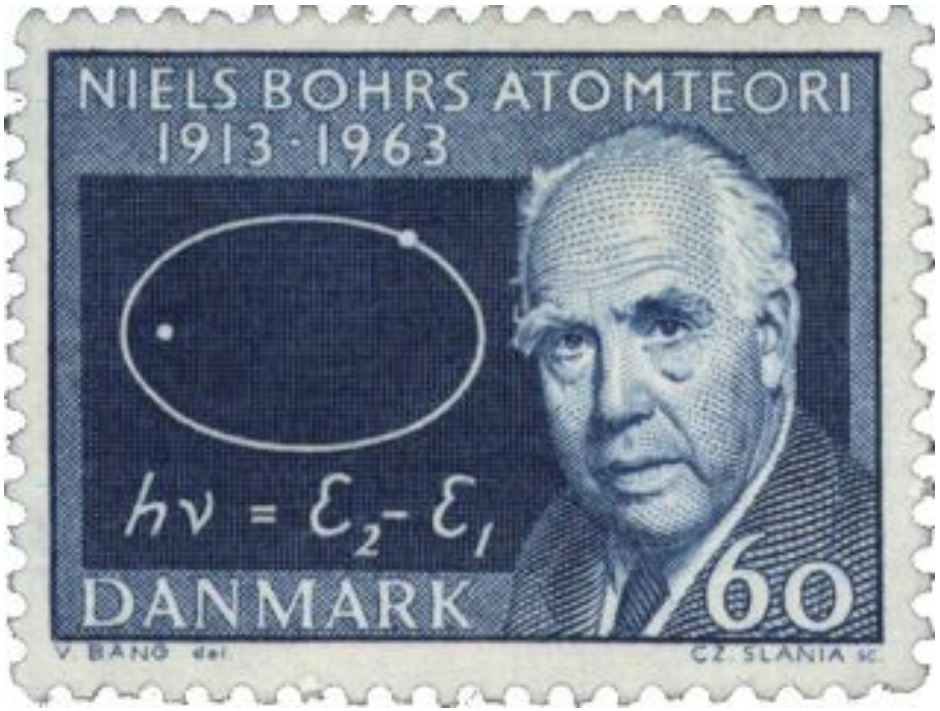
SUPERSTORM SANDY – THE NEW NORMAL?



Sandy extended from Carolinas to Canada, Atlantic to Great Lakes

Looking to the Future . . .

Prediction is difficult,
especially about the future.

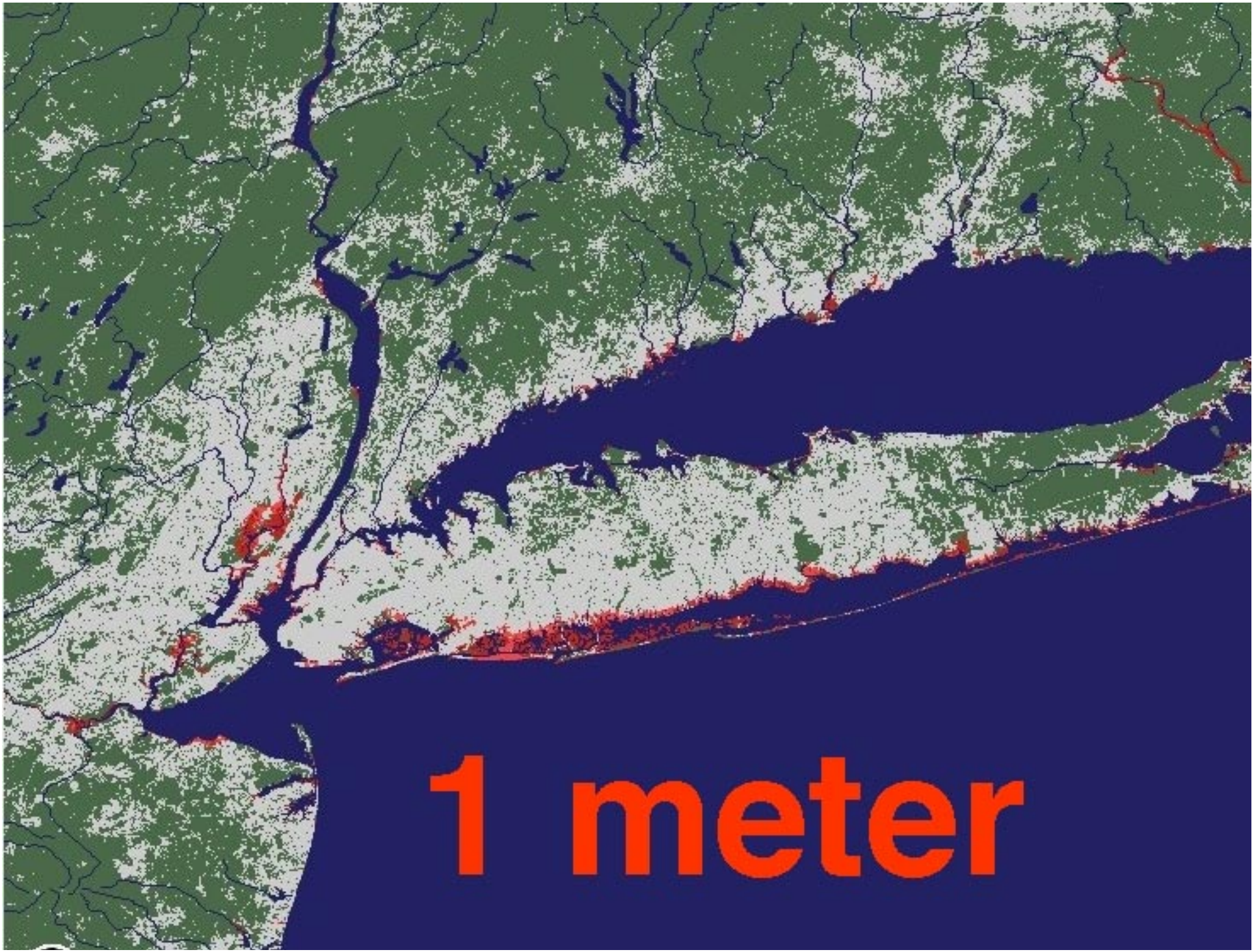


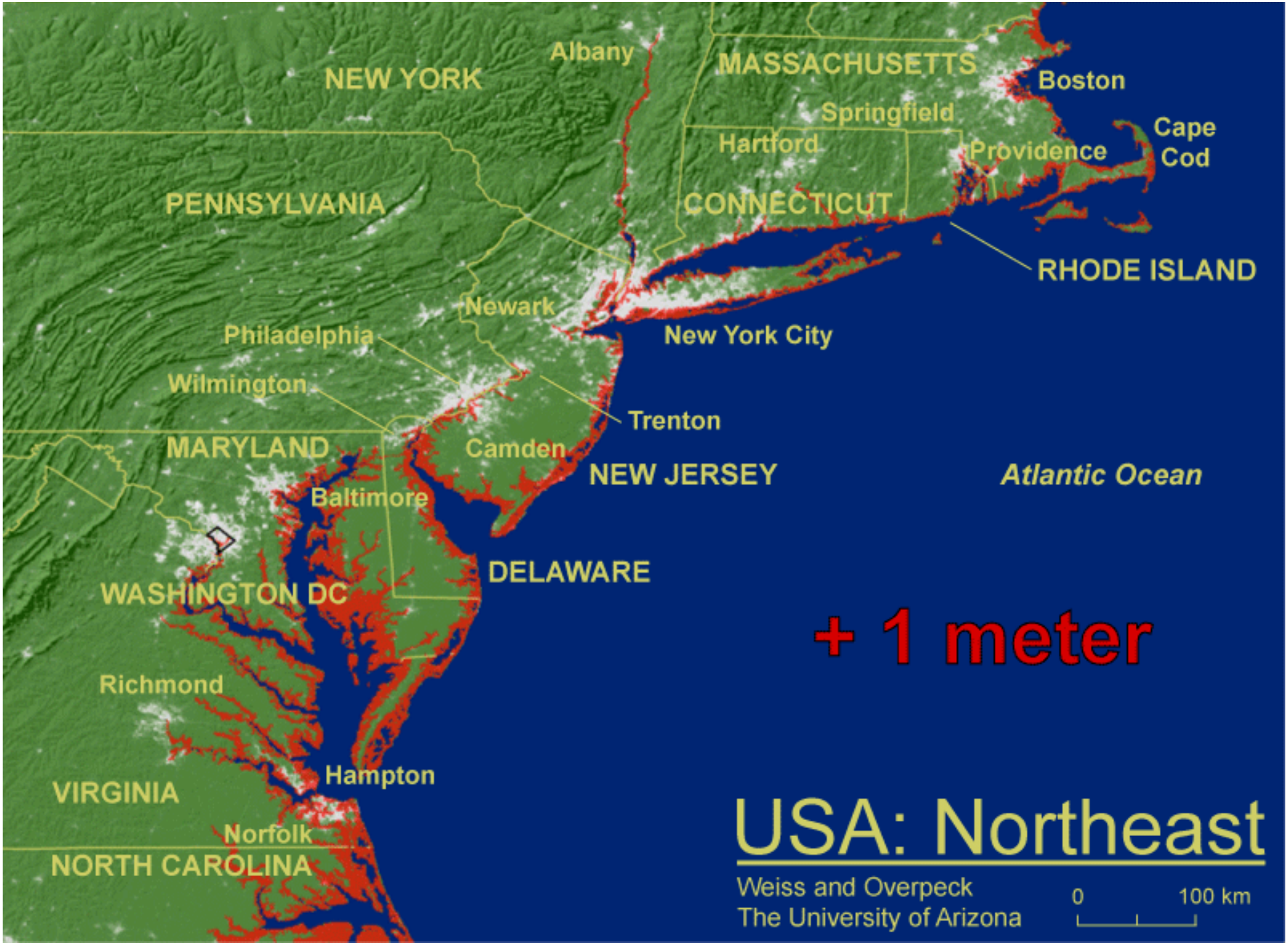
– Niels Bohr

WHAT WILL BE THE FUTURE CLIMATE OF ILLINOIS?

It will be as if you move Illinois 200 miles south.

But we don't know if it will be moving to Georgia or the Texas panhandle.


1 meter


NEW YORK
Albany
MASSACHUSETTS
Boston
Springfield
Hartford
Providence
Cape Cod
PENNSYLVANIA
CONNECTICUT
RHODE ISLAND
Newark
Philadelphia
New York City
Wilmington
Trenton
MARYLAND
Camden
NEW JERSEY
Atlantic Ocean
Baltimore
DELAWARE
WASHINGTON DC
+ 1 meter
Richmond
Hampton
VIRGINIA
Norfolk
NORTH CAROLINA
USA: Northeast
Weiss and Overpeck
The University of Arizona
0
100 km

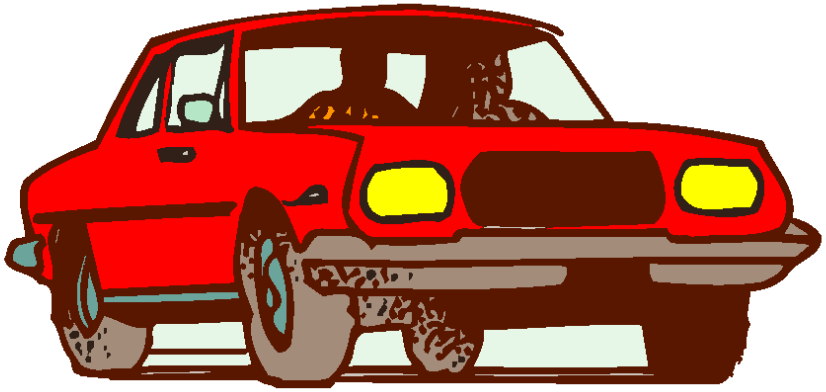
"Gentlemen, it's time we gave some serious thought to the effects of global warming."

YOU!

IS THERE ANYTHING WE CAN DO?

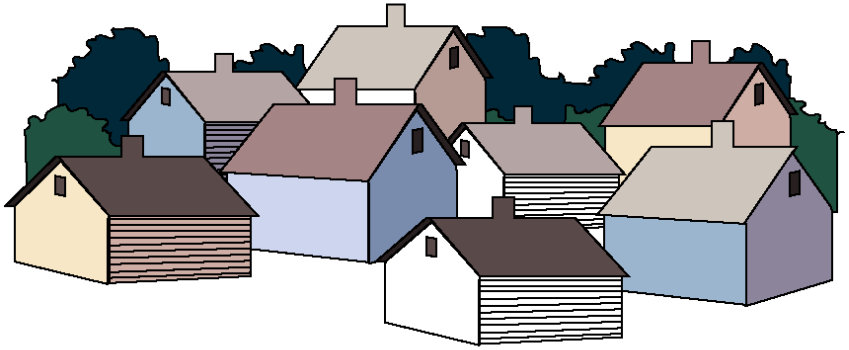
WHERE IS THIS CARBON DIOXIDE COMING FROM?

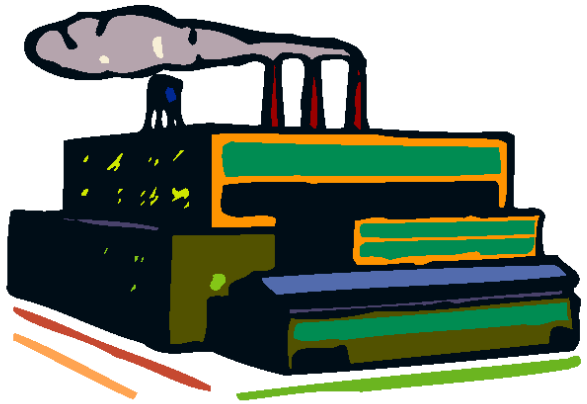
WE ARE ALL RESPONSIBLE.



Burning a gallon of gasoline in your car puts 5 pounds of carbon in the atmosphere as carbon dioxide (CO_2), and it will stay there for decades — maybe a century!

Other sources are home heating and electric power production.





SOLAR PHOTOVOLTAIC ENERGY

Decrease your carbon legacy by generating your own electricity

Decrease your electric bill, too; maybe even to zero!

ENERGY EFFICIENT CARS

Decrease your carbon legacy by driving an energy efficient car

Decrease your gasoline bill, and drive in HOV lane, too!

Global Atmosphere, Global Warming

QUESTIONS ABOUT GLOBAL WARMING

- IS IT REAL?
- IS IT IMPORTANT?
- WHAT IS IT DUE TO?
- HOW MUCH MORE CAN WE EXPECT?
- ARE WE SEEING JUST THE TIP OF THE ICEBERG?

RESEARCH IS HELPING TO ANSWER THESE QUESTIONS.

www.ecd.bnl.gov/steve

THANK YOU

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